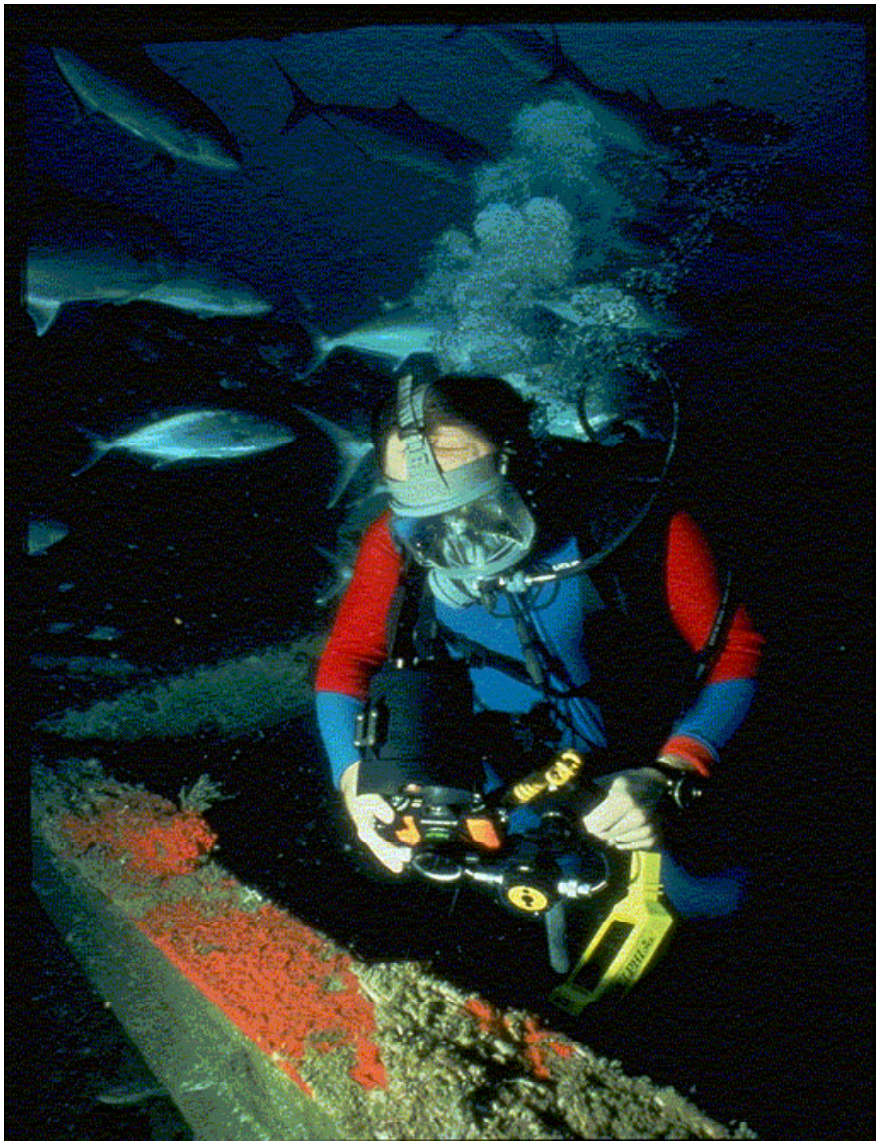


Safe Diving

The Outer Continental Shelf Lands Act of 1978 authorized NOAA to perform studies to improve the safety and efficiency of all divers—scientific, commercial, and recreational. NURP carries out this mandate for NOAA through development and support of innovative dive technologies and techniques. More than 600 scientists and students each year receive advanced diver training and field support for their research. In addition, program outreach includes notable public service efforts such as the *NOAA Diving Manual* (NOAA's most popular publication) and the Diver Alert Network (a safety net for divers around the world).

This chapter discusses ways NURP increases the safety and productivity of scientific divers.

Scientific Diver Training and Technology

Decompression sickness (DCS or "the bends") is the most common diving ailment due to pressure. While diving, gas builds up in the diver's tissues, particularly the inert gas nitrogen which makes up 78 percent of the air we breathe. If the diver ascends and reduces the pressure too quickly, these gases may come out of solution too fast in the blood stream and form bubbles, much like a soda bottle that is opened too quickly. Early symptoms may include nausea, dizziness, tingling or numbing sensation in extremities, and joint pains (thus the name the bends). Primary treatment, called recompression, simply involves getting the diver back under pressure and bringing the diver up slowly. Another problem when diving below 30 m (98 ft) on air is nitrogen narcosis, or "rapture of the deep," characterized by disorientation and confusion which can be dangerous when diving deep. One way to reduce the risk of DCS and nitrogen narcosis is to reduce the amount of nitrogen in the diver's air by replacing it with oxygen. The resulting breathing mixture is called nitrox. The benefits are obvious. Besides a clearer head, a diver using a nitrox mix with 32 percent oxygen versus the 20 percent in ambient air can stay down twice as long at 40 m (131 ft).

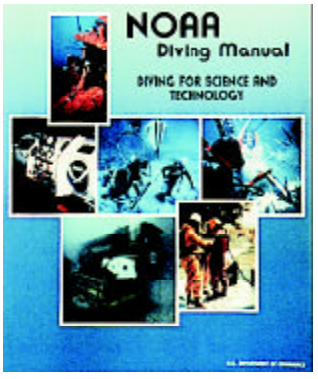
Nitrox has been used for decades by industry and the military to increase bottom time. Its acceptance by the recreational and scientific dive communities was delayed due to a lack of widely accepted dive tables and the technical problems of preparing special mixes of breathing gas. This problem was addressed in the 1979 edition of the *NOAA Diving Manual*, published by NURP, which included techniques and tables for the safe use of nitrox. "There's no special dive equipment required for using this gas mixture," said Gene Smith, NURP's program director for Diving Safety and Physiology. "That's the main appeal of nitrox." However, there are safe practices for the use and mixing of nitrox that go beyond the basic training received by most divers, Smith advised. Some practices of obtaining nitrox must be avoided, like adding 100 percent oxygen from a welding set to an old air cylinder possibly contaminated with hydrocarbons (an explosive combination). The next edition of the *NOAA Diving Manual* will include improved tables for more mixtures of nitrox improved through NURP-funded studies and useful guidelines and references for the preparation and application of mixed gases in diving.

NURP's regional center at the University of North Carolina at Wilmington provides scientists with mixed gas diving support and training. Between 1995 and 1997, the southeast center supported 5,000 nitrox dives with a flawless safety record, said David Dinsmore, director of NOAA's Diving Program, who previously served as operations director of the North Carolina center. In 1996, Mark Hay, a benthic ecologist at the University of North Carolina at Chapel Hill and his graduate students were led by NURP on more than 400 dives to "live bottom" reefs on the continental shelf off North Carolina, critical habitats for many species of commercial fish. "We simply couldn't justify the time and expense using scuba," said Hay.

Future development efforts will increase the depths and range of environments scientists can study. Too much oxygen is toxic. Gas mixtures using helium can further

NURP/UNCW

Pool training prior to *Aquarius* saturation mission.



NURP's Active Dive Record 1995-1997

	Subs	ROVs	SCUBA	Participants
Total	796	1132	20945	2618

NURP actively provides undersea technologies for scientific research including submersibles, ROVs (Remotely Operated Vehicles) and SCUBA (Self-Contained Underwater Breathing Apparatus).

increase the productivity of divers without "rapture of the deep." The key to all program efforts is to increase the productivity of scientific diving without sacrificing safety. "Scientists now know that they can more safely and efficiently achieve their dive plans with nitrox, " Smith said. "NURP gave NOAA the ability to acquire these advanced commercial and military diving techniques."

Diving Tools

Diving is made safer and more efficient with tools developed by NURP. The fourth edition of the *NOAA Diving Manual* is due out this fall. The new diving manual has been expanded and revised with instructions, recommendations, and general guidance for performing a diversity of tasks underwater. The Manual contains valuable information on topics such as the latest diving equipment, working dive procedures, diving under special conditions, hazardous aquatic animals, emergency medial care, and tables for the use of mixed gas. While the latest *NOAA Diving Manual* is primarily directed toward members of NOAA and the scientific diving community, recreational divers will also find useful information on topics like the history of diving to diving physiology. The manual pools together the contributions of more than 50 authorities including scientists, doctors, commercial and recreational divers, equipment manufacturers, and educators who wish to share their knowledge and experiences of diving.

Another useful tool for divers is the *DiveTracker*™ product line, developed by Desert Star Systems of California and substantially funded by NURP-sponsored Small Business Innovation Research (SBIR) grants. This system combines precision underwater navigation, observation recording and e-mail style wireless communication in a calculator size underwater computer. What started out as a system for divers to acquire, store, and transmit environmental data from the sea floor, has been modified for a wide range of tasks. *DiveTracker*™ has guided ROVs through refinery fuel storage tanks, docked AUVs at underwater fueling and data exchange stations, monitored U.S. Army Ranger recruits for signs of hypothermia, and aided the U.S. Navy in the recovery of torpedoes after test firings. *DiveTracker*™ will be used by NURP science divers on research missions at the *Aquarius 2000* undersea habitat.

Public Service

These days, you will not find a diver with any experience who is not familiar with DAN—the Diver's Alert Network. DAN was established in 1980 at Duke University Medical Center with support from NURP and the National Institutes of Health to provide a medical advisory service for divers. In case of dive injuries, divers or physicians can call the DAN 24 hr. emergency hot-line and talk to a dive physician. If needed the physician will work with a DAN Regional Coordinator to arrange referral and transport to an appropriate medical facility. For a modest fee a diver can join DAN and purchase diving medical insurance that covers all treatment costs including helicopter transport if needed. In 1998, DAN estimated they have taken more than 140,000 calls for diving medical assistance, and annually advise in the treatment of up to 500 divers worldwide. DAN programs are described at their world-wide-web site, http://www.dan.ycg.org.

The Diver's Alert Network logo.